ASTR278

Advanced Astronomy

S2 Day 2019

Dept of Physics and Astronomy

Contents

General Information

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Credit points
3

Prerequisites
PHYS201

Corequisites

Co-badged status

Unit description
This unit is based around a major experimental project in observational astronomy. Lectures, labs and tutorials in the first half of the unit provide students with the tools needed to design and execute an open-ended observational project in the 2nd half. Topics on observational astronomy (e.g. galaxies, stars, exoplanets) are covered alongside data and instrumentation requirements. Hands-on lab and project work provide a foundation in optical and radio telescope design and instrumentation. Python programming for image processing and analysis of large datasets are introduced and developed in the labs and major project. Modern project management tools and best-practice in experimental design are incorporated into the unit.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.

Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.

Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.

Apply python computer programming and industry-standard software tools to real-world situations.

Demonstrate project management and teamwork skills.

General Assessment Information

This unit has hurdle requirements, specifying a minimum standard that must be attained in aspects of the unit. To pass this unit you must obtain a mark of at least:

- 50% in the unit overall

as well as

- 40% in the mid-term examination

Late Assessments Policy

The non-examination assessment components should be submitted via iLearn or CoCalc by the due date and time.

The penalty for late submission is deduction of 5% of the possible mark for that item for each 24 hour period (or part) overdue. Assessments will not be accepted for marking if submitted more than 1 week past the due date. Extensions to the due dates for assignments, practical assessments, and project will only be considered if requested with valid reason *prior to the due date*.

Students anticipating or experiencing difficulties in meeting a deadline should discuss this with one of the lecturers in the first instance, ideally ahead of the deadline, if at all possible. Students should also be familiar with the University's Disruptions to Study policy (http://www.mq.edu.au/policy/docs/disruption_studies/policy.html).

Assessment Tasks

Name	Weighting	Hurdle	Due
Major Project	60%	No	Details below
Mid-Semester exam	20%	Yes	Tuesday 1-3pm during Week 7
Labs	20%	No	1 week after each lab

Major Project

Due: **Details below**
Weighting: **60%**

Pairs of students will propose to work on an intensive Major Project with aims based upon the Project Questions given below.

Project Questions available this term

Can useful scientific measurements be made in the light-polluted environment of Sydney? *Using imaging at Macquarie Observatory to measure the age of Milky Way star clusters. Compare to data taken in dark sky location.*

Can we make a modern measurement of Jupiter's mass to help with the Juno spacecraft ephemeris? *Use imaging at Macquarie Observatory to track the moons movements around Jupiter.*

How well can we measure the speed of light from Jupiter's moons using modern astronomical instrumentation? *Use imaging at Macquarie Observatory to track the moons movements around Jupiter.*

Is the radio frequency interference environment at Macquarie too bad for setting up a radio interferometry at Macquarie? *Monitor radio frequency interference levels throughout campus.*

Assessment details

Detailed assessment rubrics will be provided on iLearn for each of the assessments.

Reflective writing - 5% of unit mark - Assessed throughout term

In the first half of the unit, students will write weekly reflective entries on how tools, methods, concepts covered in Lectures, Special Lectures, Labs and Tutorials might be adapted or used for the Major Project.

In the second half of the unit, students will write weekly reflective entries on topics related to the Major Project.

Project proposal - 10% of unit mark - Due Week 6

A proposal template will be provided on iLearn. Team proposal outlining Major Project details:

- scientific and technical backgrounds
- project aims, including a stretch goal
- team roles
- project management tools to be used
- project overall timeline and weekly plan

Weekly progress - 5% of unit mark - Assessed each week during Weeks 7-12

Team meeting with Lecturer to check on progress. Main project Milestones will include:

- Establish Background: Science & Instrumentation
- Observational motivation, plan & setup
- Observe
- Process data
- Produce results

Individual exit interview - 20% of unit mark - Week 13

A 15-minute interview with each student by the Lecturers. Questions from Lecturers will assess individual learning and contributions to the Major Project.

Project report - 20% of unit mark - Draft due Week 12, Final draft due during Final Exam Period

A project report template will be provided on iLearn. The reports will include Statements of Contribution to assess individual contributions to the project report.

On successful completion you will be able to:

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.

- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.
- Apply python computer programming and industry-standard software tools to real-world situations.
- Demonstrate project management and teamwork skills.

Mid-Semester exam

Due: **Tuesday 1-3pm during Week 7**
Weighting: **20%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

The mid-semester exam will take place on Tues 1-3pm during Week 7.

Exam will cover topics in Lecture series.

The only exception to not sitting the examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to apply for Special Consideration (see 'Special Consideration Policy' in this Guide). If a supplementary examination is granted as a result of the special consideration process the examination will be scheduled by the Lecturer and student.

The mid-semester examination is a hurdle requirement. You must obtain a mark of at least 40% in the mid-semester exam to be eligible to pass the unit. If your mark in the mid-semester examination is between 30% and 39% inclusive, you will be a given a second and final chance to attain the required level of performance. The mark awarded for the second exam towards your final unit mark will be capped at 40%.

On successful completion you will be able to:

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.
- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.

Labs

Due: **1 week after each lab**
Weighting: **20%**

Labs will run during Weeks 1 to 6 in the 2nd year physics lab.

Close-toed shoes are required in the labs.

Each lab activity will last two weeks. The first activity will be focused on exercises using the Python computing language. The next two activities will focus on various hands-on astronomical instrumentation activities.

Lab reports or python notebooks must be submitted electronically to iLearn or CoCalc, as directed by the lab instructions. Each report is due 1 week after completion of the lab, before the next lab starts.

The marks will be based on:

- demonstrate understanding of lab activity instructions during a pre-lab discussion (2nd & 3rd lab activity only)
- completion of the laboratory exercises where possible
- a demonstrated understanding of the material in your report
- adherence to good experimental practice

On successful completion you will be able to:

- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Apply python computer programming and industry-standard software tools to real-world situations.

Delivery and Resources

Major Project

The Lectures, Tutorials and Labs in the first half of the unit are designed to support the activities of the Major Project. Participation in the first half is essential for identifying tools and methods required to achieve the aims of the Major Project.

Special lectures

Each week, generally the 3rd lecture of a week will include a guest lecturer. Professional astronomers will describe one of their research projects, including the science goals, project overview, telescope requirements and results. Attendance of these are strongly encouraged for the opportunity to ask questions about their projects and learn about tools or methods they employ in preparation for the Major Project work.

Normal lectures

Generally the 1st and 2nd lectures in a week will be a traditional lecture format on astronomy and instrumentation topics.

Students are expected to attend all Lectures whenever possible. Lectures attendance provides the opportunity to ask questions about content that will be covered on the mid-term exam and to prepare for the Major Project.

Tutorials

Tutorials in the first half will cover tools and methods to support the Major Project work. Most of the tutorial will be interactive sessions with the tools introduced.

Labs

Labs provide hands-on python programming and instrumentation work related to telescope and science-grade astronomical cameras. Labs provide important way to learn tools in preparation for the Major Project. The python labs will be conducted individually. The other two labs will be pairs of students, who will submit individual lab reports.

Python programming resources

The Major Project and standards labs requires use of the Python programming language. There are signfiicant resources online about how to program with python and specific tools for writing astronomy code:

- http://astropy-tutorials.readthedocs.io/en/latest/
- https://www.datacamp.com/community/tutorials/python-numpy-tutorial
- https://docs.scipy.org/doc/numpy/user/quickstart.html
- https://www.codecademy.com/learn/learn-python

Software tools

Students will get to select and use various software tools to help manage their Major Project work. Some examples will include:

- Communications & Project management
    - https://slack.com/
    - https://trello.com/
    - https://zoom.us/
    - https://www.facebook.com/groups/
- Coding
    - https://github.com/
    - https://datastudio.google.com/
- File and document sharing
    - https://drive.google.com/
    - https://www.office.com/
    - https://www.overleaf.com/

Recommended Texts and/or Materials

Required Text

There is no single textbook that covers all of the course material in this unit. Appropriate material will be provided during the course. Useful textbooks are listed below.

Recommended Reading/Useful References

Foundations of Astrophysics by Barbara Ryden, Addison-Wesley, (2009)

Observational Astrophysics by Robert C. Smith, Cambridge University Press (1995)

Astrophysical Techniques, C R Kitchin, Institute of Physics Publishing (2003)

Adaptive Optics for Astronomical Telescopes, John W Hardy, Oxford University Press (1998)

Astrophysical quantities, C W Allen, London : Athlone Press (1973) ISBN0485111500e

Teaching and Learning Strategy

This unit is taught through a Major Project, Lectures and through undertaking laboratory experiments. The Major Project follows a project-based learning paradigm with team self-directed projects. The open-ended nature of the projects allows student definition of the project’s goals and find the tools required to achieve those goals.

Questions during and outside Lectures are strongly encouraged in this unit - please do not be afraid to ask as it is likely that your classmates will also want to know the answer.

Unit Schedule

The first half will consist of Lectures, Tutorials and Practicals. Laboratories (practicals) are compulsory and will commence in the first week of semester.

The second half will mostly be lab-based work on the Major Project. No Lectures will be given, instead the lab will be open and a lecturer available for Major Project work.

Tutorials on Astronomical Instrumentation will be given during the 2nd half. A night visit to use the Macquarie Observatory for the Major Project will form an important part of the Major Project as data collected at the observatory will be used in some of the Major Projects.

The order of the Weekly Lectures themes below might change due to Expert availability.

Week	Theme	Special note
	Introduction to unit	**For 2nd and 3rd Lecture sessions during Week 1, meet at Australian Astronomical Observatory (https://www.aao.gov.au/location) for Major Project Introduction**
	Radio science and telescopes	
	Exoplanets and atmosphere	

Week	Theme	Special note
	Stars clusters and spectroscopy	
	Photometry and imaging	
	Observing and Adaptive Optics	Project Proposal due.
	Major Project work	Mid-term exam.
	Major Project work	
	Major Project work	
	Major Project work	
	Major Project work	
	Major Project work	Draft Major Project report due.
	Major Project work	Individual interviews.
	Major Project work	Final Major Project report due.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy (***Note:*** *The Special Consideration Policy is effective from 4*

December 2017 and replaces the Disruption to Studies Policy.)

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/

offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcome

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.

Assessment task

- Major Project

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcomes

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.
- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.
- Demonstrate project management and teamwork skills.

Assessment tasks

- Major Project
- Labs

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.
- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.
- Apply python computer programming and industry-standard software tools to real-world situations.

Assessment tasks

- Major Project
- Mid-Semester exam

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.
- Apply python computer programming and industry-standard software tools to real-world situations.

Assessment tasks

- Major Project
- Mid-Semester exam
- Labs

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.
- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.
- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.

Assessment tasks

- Major Project
- Mid-Semester exam
- Labs

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.
- Explain a range of instrumentation topics and apply a subset of instrument knowledge to project work.

- Explain a range of observational astronomy topics and apply a subset of astronomy knowledge to project work.
- Apply python computer programming and industry-standard software tools to real-world situations.

Assessment tasks

- Major Project
- Mid-Semester exam
- Labs

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Apply python computer programming and industry-standard software tools to real-world situations.
- Demonstrate project management and teamwork skills.

Assessment tasks

- Major Project
- Labs

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

- Develop intuition on the relationship between experiment design and gaining new knowledge about physical phenomena.
- Demonstrate project management and teamwork skills.

Assessment task

- Major Project

Changes from Previous Offering

Lecture and lab content have been updated and refreshed based upon feedback from previous years.

Marking schemes have been refreshed and improved to help with establishing expectations.

Weight of marks in the Major Project has changed.

Feedback

Student Liaison Committee

The Physics Department values quality teaching and engages in periodic student evaluations of its units, external reviews of its programs and course units, and seeks formal feedback from students via focus groups and the Student Liaison Committee.

Please consider being a member of this committee, which meets once during the semester (lunch provided), with the purpose of improving teaching via student feedback. The class will be asked to nominate two students as representatives for the ASTR278 unit on the student liaison committee. This nomination process will be conducted during lectures and the lecturer will forward the names to the Head of Department.

The SLC meetings are minuted and student representatives receive copies of the minutes from the two preceding SLC meetings prior to the meeting. An update on the responses that have been made by the department to the feedback obtained at the two preceding SLC meetings are reported by the Head of Department at the beginning of each SLC meeting. These responses are also minuted.

The feedback is acted upon in a number of ways mostly initiated via Department of Physics and Astronomy meetings, where decisions on actions are taken.

Standards Expectation

Grading

An aggregate standard number grade (SNG) corresponding to a pass (P) is required to pass this unit.

High Distinction (HD, 85-100%): provides consistent evidence of deep and critical understanding in relation to the learning outcomes. There is substantial originality and insight in identifying, generating and communicating competing arguments, perspectives or problem solving approaches; critical evaluation of problems, their solutions and their implications; creativity in application.

Distinction (D, 75-84%): provides evidence of integration and evaluation of critical ideas, principles and theories, distinctive insight and ability in applying relevant skills and concepts in relation to learning outcomes. There is demonstration of frequent originality in defining and analysing issues or problems and providing solutions; and the use of means of communication appropriate to the discipline and the audience.

Credit (Cr, 66-74%): provides evidence of learning that goes beyond replication of content knowledge or skills relevant to the learning outcomes. There is demonstration of substantial understanding of fundamental concepts in the field of study and the ability to apply these concepts in a variety of contexts; plus communication of ideas fluently and clearly in terms of the conventions of the discipline.

Pass (P, 50-65%): provides sufficient evidence of the achievement of learning outcomes. There is demonstration of understanding and application of fundamental concepts of the field of study; and communication of information and ideas adequately in terms of the conventions of the discipline. The learning attainment is considered satisfactory or adequate or competent or capable in relation to the specified outcomes.

Fail (F, 0-49%): does not provide evidence of attainment of all learning outcomes. There is missing or partial or superficial or faulty understanding and application of the fundamental concepts in the field of study; and incomplete, confusing or lacking communication of ideas in ways that give little attention to the conventions of the discipline.